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Particle acceleration in co-axial plasma channels

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The attainable transformer ratio in plasma accelerators is limited by instabilities. Using three-dimensional particle-in-cell simulations, we demonstrate that these can be controlled using a hollow plasma channel with a coaxial plasma filament. The driver scatters electrons from the filament, and the slow pinch of the ions leads to a strong chirp of the effective betatron frequency, preventing beam breakup. We demonstrate the monoenergetic acceleration of an electron bunch to 20 GeV over 4.4 m, achieving a transformer ratio of 10, an energy efficiency of 40%, and an emittance of 1.8 μm.
We discuss the source of emittance growth inside the channel and options to eliminate it. This might open a path toward high energy acceleration of both electrons and positrons.
A practical possibility for creation of the co-axial plasma structure will be discussed as well.

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